The Concept of Nature – from Plato's World to Einstein's World

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Nature is not a simple concept – for at least three reasons. First of all, nature, meaning the physical universe, is in itself an evolving nature. It is neither fixed nor always the same. There is biological evolution (genetic diversity and variation) and – derivatively (though the concept is problematical) – cosmic evolution, e.g. stellar evolution. Therefore, concepts of nature follow nature in its evolution or ought to follow it. Second, nature has, at least in a historical perspective, different meanings in different cultures. For example, the Greek tradition distinguishes between creative nature (*natura naturans*) and created nature (*natura naturata*), the Indian tradition identifies nature and earth and speaks of the Goddess Earth. Today, under the influence of the modern sciences, historically divergent concepts of nature have lost their scientific significance. Nature is now what is governed by universal laws, although, as we know now, a universal determinism is limited in many ways by the occurrence of probabilities, i.e. by probabilistic laws. Third, though initially nature was just that part of the world that man had not made, it has now, to a great extent, become part of an artificial world built by science and technology. This makes it difficult to distinguish clearly between what is natural and what is not. For example, what is the exact meaning of the concept of nature for the particle physicist, who, so to speak, 'creates' his objects in big machines, or for the molecular biologist, who rearranges genomes? Is it still nature that scientists investigate and humanists reflect on when they speak about nature and culture and the cultural impact of science and technology on nature? It is not only that different cultures have generated different concepts of nature, but also that science interferes with nature in a way that makes it often difficult, even with respect to the concept of universal laws of nature or probabilistic laws, to give a determinate definition of what nature is. The old duality between nature and culture as well as the duality between universalism or determinism and probabilism has been superseded by a plurality of new dualities, among which is again also the duality between a creative or evolving nature and a created nature (now in a scientific framework).

Closely connected with changing concepts of nature are *world views* or *world pictures*. World pictures are models of the reality, depending on

particular *concepts*, like the concept of nature, *beliefs* about how the reality functions, and programmes, like scientific *programmes*. It is not only mythical cultures which create world pictures; science, too, generates them. It provides the world with a picture in which it appears as what it ostensibly is 'in itself', as 'nature', as 'evolution', as 'creation', regardless of how we transfer the conception of a 'world outside us' to 'our' world, the world in which we live. To an understanding of science also belongs an understanding of its power to constitute the world and to generate world pictures, particularly with respect to nature. In the following, some examples are given of how science pictures nature and the world – from Plato's and Aristotle's world to Einstein's and Heisenberg's world.[1]

With Plato's world, i.e. with Plato's cosmological concept, the idea of a philosophical as well as a scientific cosmology is born. Here, in Plato's dialogue *Timaios*, a powerful craftsman creates the world according to a perfect model, namely the 'cosmos' of the Platonic ideas. Like a perfect living being, the cosmos turns out to be an animated rational being, as a visible god in the form of a perfect sphere. Its soul, the 'world soul', has an astronomical nature: it is formed by the mathematical order of the trajectories of the planets. At the same time the planets function as 'tools of time'; time (καιρός), arising with the heavens, is an image of eternity (αἰών). The planets are visible and created gods, the earth the 'most venerable goddess in the heavens'. Man in the cosmos, which consists of purely godlike entities and is itself a living god, is compared with a plant, which roots 'not in the earth but in the heavens'; he connects the earth with the heavens related to him. Later on, in Christian thought, i.e. in Christian Platonism, the world of Platonic ideas to which the craftsman refers as a perfect model, becomes the realm of thoughts of God creating the world.

Unlike a *Plato world*, which, apart from the mythical language in which it is presented, is governed by mathematical (geometrical) and astronomical laws, Aristotle's world is a world of natural things that consist of matter and form and have within themselves a source of motion. Motions caused by

[1] This is a short and revised version of an earlier contribution which also dealt with questions of the history and philosophy of science: J. Mittelstrass, "World Pictures: The World of the History and Philosophy of Science", in: J.R. Brown, J. Mittelstrass (Eds.), *An Intimate Relation. Studies in the History and Philosophy of Science. Presented to Robert E. Butts on His 60th Birthday, Dordrecht*/Boston/London: Kluwer Academic Publishers 1989 (*Boston Studies in the Philosophy of Science* 116), pp. 319-341, particularly pp. 322-330 (*2. The World of Science*).

such a 'natural' source are 'teleological' motions, i.e. they make a thing into what, according to its own nature, it really is, or they lead it, in the form of a 'natural' local motion, to its 'natural' place. A theory of natural positions, incorporated in a theory of elements, corresponds in this sense to a theory of simple (natural) bodies (bodies that have a source of motion in themselves) and simple motion (the motion of simple bodies). In the cosmological dimension, an *Aristotle world* consists of eleven spheres grouped around the central body, earth. Each such sphere is constituted by two concentric spherical surfaces: the three inner spheres housing the elements and the eight outer spheres housing the then known planets and the system of fixed stars (with a daily rotation about the axis of the heavens). The geocentrism of the Aristotle world is a result of the Aristotelian theory of elements or the theory of natural positions. That a heavy body falls to the earth is a result of the centre of the cosmos' being the natural position for this body, i.e. the motion of heavy bodies is not toward the earth (this is only *per accidens*), but toward the centre of the cosmos (*per essentiam*).

In opposition to the atomistic conception of the constant movement of atoms, the Aristotle world is characterized by the notion that every movement requires a mover. Thus, not only the change of motion, but also the uniform motion of a body requires a causal force. This force must either reside in the moving body itself (in the form of a motivating 'soul' or as a natural movement) or exist in direct contact with it; action at a distance is not permitted. The place of atoms in atomistic conceptions is filled by so-called *minima naturalia*, i.e. the smallest particles of matter that place a natural limit on its divisibility without altering its substantial form. Correspondingly, all matter has quantitative minima that possess the characteristics of macrobodies made from it. These *minima* also possess a characteristic size, though their geometric form is not predetermined. In chemical processes, *minima* in immediate proximity to each other constitute a *qualitas media*, which is the basis for the *forma mixti* of matter which possesses a particular substantival form. (According to atomistic conceptions, all that changes in chemical processes is the configuration of the smallest particles, which lack qualitative characteristics and whose geometric form is constant.)

The Aristotle world is thus characterized by a high degree of *experiential evidence*. The scientific propositions describing this world are confirmed by the experience acquired in everyday life, or are derived through generalizations made on the basis of experience. Examples of this are (1) the Aristotelian law of gravitation, according to which the velocity of a falling body is proportional to its weight and inversely proportional to the den-

sity of the medium, (2) the above-mentioned Aristotelian 'law of inertia', which states that all things moved have a mover, and (3) the Aristotelian theory of elements with its familiar concepts derived from the experience of daily life, for example, 'above', 'below', 'natural', and 'unnatural' (as in the case of violent movements that run counter to natural movements). The Aristotle world, moreover, is always in the process of becoming a natural order, embedded in the inner teleology of this world or the teleological nature of all things. This natural order never appears as a perfect state, but it is constantly present in the form of an astronomically ordered, supralunary world. In other words, disorder as well as the tendency to order is the normal state of the (sublunary) world. It is the world of experience and hence – despite physics and natural philosophy which seek to interpret it – a very human world.

As opposed to the Aristotle world, a hermetic world – by which is meant the world of alchemy, astrology, and parts of natural philosophy in the Renaissance – is a world of mysterious interactions. Occult powers and living substances take the place of the simple bodies characteristic of the Aristotle world. Nature consists of different combinations of primary substances that originated in undifferentiated primordial matter. At the same time, these combinations are conceived of as developmental processes that man can accelerate or retard, though always with methods that 'imitate nature', for example, by 'refining' metals and other substances (*transmutatio*). Inorganic processes are viewed analogously to organic processes. Explanations of the world take the shape of allegorical interpretations: coming into being and passing away as birth and death, separation and unity as the polarity of the sexes (the *conjunctio* as sexual union or the hermaphrodite as the overcoming of sexual differences).[2]

This conception finds its cosmological expression in the correspondence between *macrocosm* and *microcosm* which interprets the world in antiquity and in the hermetic tradition as a great organism mirrored in the microcosm, particularly in man: "what is below is like what is above; what is above is like what is below: both reveal the miracle of the one".[3] The influence of the macrocosm on the microcosm corresponds to the ever-pres-

[2] See Chr. Thiel, "Alchemie", in: J. Mittelstrass (Ed.), *Enzyklopädie Philosophie und Wissenschaftstheorie*, vol. I, 2nd ed., Stuttgart/Weimar: J.B. Metzler 2005, pp. 75–83.

[3] The first sentence of an apocryphal text attributed to Hermes Trismegistos. See Chr. Thiel, "Makrokosmos", in: J. Mittelstrass (Ed.), *Enzyklopädie Philosophie und Wissenschaftstheorie*, vol. V, 2nd ed., Stuttgart/Weimar: J.B. Metzler 2013, pp. 186–189.

ent assumption in magical thought that it is possible to effect a change in the macrocosm through changes in the microcosm. This conception, as the 'sympathetic' relationship between all of the parts of the world, is still at work within the context of natural philosophy in the Romantic period: man as a microcosm "in which the universe looks at itself".[4]

In a *Hermes world* everything becomes a riddle or a key to solving its secrets. The familiarity of the Aristotle world gives way to a demonic world that is only accessible through ritual and mystical forms of knowledge. The scientist becomes in this way the mediator between two worlds, a life-world and a hermetic world, and at the same time the real 'addressee' of his own hermetic knowledge. The alchemical *separatio* reproduces itself as the *separatio* of the material and mystical body (the 'diamond body') in the scientist. It constitutes the actual *magisterium*, i.e. the 'great work', the self-development or spiritualization of man. Thus the hermetic world stands not only in opposition to the familiarity of the Aristotle world, but also in opposition to the mechanistic world that in the modern age begins to supplant both the Aristotle world, as well as Aristotelian physics.

The foundation for this mechanistic world picture is Newton's world. In this world it is only (gravitational) mass that moves in absolute time, through absolute space. Matter and space are the real elements of this world. The smallest particles of matter, hence the actual atoms, combine to build complex formations or second-degree particles. Several of these combine in turn to become third degree particles and so forth. The inner structure of matter is thus characterized by a complex hierarchy of particle formations. These formations are not massive corpuscles, but contain empty space. As the order of the particle hierarchy expands, the amount of empty space in them increases while the extent of solid matter decreases correspondingly. Matter in the world is thus only seemingly solid. In fact, the world is a vacuum for the most part. The actual amount of solid matter in the universe could fit into a nutshell (atomistic nutshell theory).

Characteristic of the *Newton world*, moreover, is the assumption that a fundamental dualism exists between passive matter and active immaterial principles. According to this notion, which can be traced back to Cambridge Platonism and hence to hermetic conceptions of the world, matter can be the origin only of mechanical effects, that is, effects mediated by pressure and impulse. Matter itself does not exert force, but only withstands

[4] J.J. Wagner, *System der Idealphilosophie*, Leipzig: Breitkopf und Härtel 1804, p. LIII.

the effects of forces (through its own inertia). Gravitational pull, in particular, is not a trait of matter. Gravitation has more the status of an active principle and finds its origin in a non-material ether that exerts an effect on matter. Matter, 'inanimate and brute', is not able to guarantee even halfway stable processes of development through its essential characteristics. Since in this world a general principle for the conservation of energy does not hold, mechanical interactions lead to a steady loss of movement, which cannot be fully compensated for by the active principles that bring forth new movement. All the regularly functioning causes (material or immaterial) taken together would not be able to impede the movement of the world toward disorder and chaos. The stability of the world, i.e. compensation for the energy loss, is a matter only for God or an occasional divine intervention in this world.

The nutshell theory of matter on which this world is based corresponds, as regards its concept of space, to a container or arena theory. The space of the Newton world is not formed by spatial relations of material bodies (concept of relational space), but exists 'in and of itself' as an ontological entity on the same level as matter. Space is independent of matter. In proving the existence of inertial forces, Newton attempts to endow the related concept of absolute space, i.e. the conception of a stationary system of coordinates that differs from the mere relative state of rest between bodies, with experimental content. He himself tried to show that the centrifugal forces generated by rotational movement cannot be traced back to relative rotations of whatever type, i.e. they have to be conceived of as 'true' rotations, as rotations against an absolutely stationary space. This absolute space is analogous to the *sensorium Dei*, i.e. the omnipresence of God put into law (following here the Cambridge Platonists as well). Just as the mind of man can receive sense impressions through its presence in his brain, so God perceives the processes in the universe through his presence in absolute space.

The 'mechanism' of the Newton world, expressed in a mechanics of gravitational movement, in Newtonianism not only determines how inorganic nature is understood but also proliferates itself in the organic, psychic, and social cosmos. In the theological aspects it still retains, this mechanism documents their fundamental dispensability. The criticism of the effects of occult powers (qualities) in a hermetic world also applies to Newton's theological legitimations. The Newton world, the quintessential 'mechani-

zation of the world picture', becomes a 'world of machines' – with God as a retired engineer.[5]

In contrast to the concept of absolute space in the Newton world, a concept of relational space is dominant in Einstein's world. Here space is constituted only by matter, with energy also being matter. In order to do justice to the special effects of rotation discovered by Newton, Einstein refers to 'Mach's principle', which considers the centrifugal forces not as the result of true rotation (rotation against absolute space) but as the effect of rotation relative to distant masses (that is, the centre of gravity in the universe). Einstein's general theory of relativity attempts to give Mach's programmatic idea a physical dimension in order to establish the validity of a theory of relational space in terms of epistemology as well as physics.

Particularly relevant philosophically is the idea of a *geometricization of nature*. In the general theory of relativity, gravitation (with certain restrictions) is no longer conceived of as a force that diverts bodies from their natural trajectory, but as an entity that is inseparably bound up with the structure of space and time. If one examines the trajectory of a body in the field of gravitation from an adequate standpoint, one would recognize that this body actually follows the most linear trajectory. Later Einstein also tried to apply this idea to electromagnetic forces in order to achieve a unified theory of gravitation and electrodynamics. The central idea was that all interactions between particles can be traced back to space-time structure. This means that a particle has an effect on space-time, which in turn has an effect on a second particle and in this way mediates the interaction between the two.

Matter itself, however, is not included in the unification. Particles are singularities of the fields, i.e. particles are not themselves solutions to the field equations. Where particles are, the field equations are not valid. Both ponderable matter as well as fields can be viewed as matter in a broader sense. Both possess physical reality in the same sense. Since the field of gravitation in particular is of this type and at the same time is identified through the general theory of relativity with the space-time structure, matter is everywhere where space is. The *Einstein world* is not virtually empty like the Newton world, but full like a Cartesian world. Like the Newton world, however, it is subject to deterministic considerations in the form of a unified theory of interactions. Thus, in the Einstein world there are no

[5]E.J. Dijksterhuis, *De Mechanisering van het Wereldbeeld*, Amsterdam: Meulenhoff 1950, p. 539.

essentially accidental elements; everything is predetermined from the beginning and takes place necessarily. God does not throw dice.

It is characteristic of the special as well as the general theory of relativity that the essential geometric quantity is a four-dimensional metric interval. This can be divided into a spatial and a temporal component, and yet this division is dependent on the system of coordinates used. Einstein draws the conclusion from this situation that the 'transient now' (the idea of a shifting present) possesses no objective meaning. He draws the same conclusion from the symmetry of equations in mechanics and quantum mechanics against time reversal. In all elementary processes there is no difference between past and future. Such a difference is a mere illusion. In reality there is no development, no actual change. All that is real is a static, four-dimension- al state of being. In this sense the Einstein world is neither Aristotelian nor hermetic nor Newtonian, but Parmenidean.

The examples cited here demonstrate the power of science to constitute worlds and generate world pictures. There can be no doubt that it fulfils this role. But the brief discussion of the Plato, the Aristotle, the Hermes, the Newton, and the Einstein world demonstrate even more. In the final analysis, these examples reveal not only that science makes worlds, but there is also a certain relativity of scientific worlds. Each of these worlds, with respect to the scientific (or philosophical) view of things on which they are based, has its own plausibility, and each is somehow consistent. What they show – quite apart from the fact that nobody today, in a scientific world as well as in the life world, wants to go back to an Aristotelian or an hermetic world – is a growing loss of perceptibility and an increasing distance to what is understood by nature. There is no room left for perceptibility in an Einstein world, let alone the world of quantum mechanics, a *Planck* or *Heisenberg world*, in which particles no longer move on trajectories like in classical physics and the law of causality no longer holds. The same is true with the concept of nature. Newton's concept of nature is different from that of Aristotle, and Einstein's concept of nature (if there is one) is different from that of Newton. Physics, as it appears, has lost the concept of nature; it is biology which may bring it back.